

# LIVESTOCK LEGACY



Behind those pristine packages of pork chops at the market is a dirty little secret. Actually, it's not so little: the 60 million hogs in the United States produce an estimated 100 million tons of feces and urine each year, according to statistics from the U.S. Department of Agriculture and the American Society of Agricultural Engineers. And it's not such a secret anymore: last summer a series of hog waste spills fouled streams and rivers in Iowa and North Carolina, the two top hog-producing states in the country.

Livestock waste spills can introduce enteric pathogens and excess nutrients into surface waters. The waste can also contaminate groundwater with nitrates and contaminate air with ammonia and odors so offensive that they make people angry and depressed. While livestock waste regulations vary from state to state, most are based largely on voluntary compliance. Opinions on the best way to keep livestock waste out of the air and water vary widely. At issue are the level and degree of both regulation and waste management technology.

Although recent waste spills put hogs in the national spotlight, cows and poultry

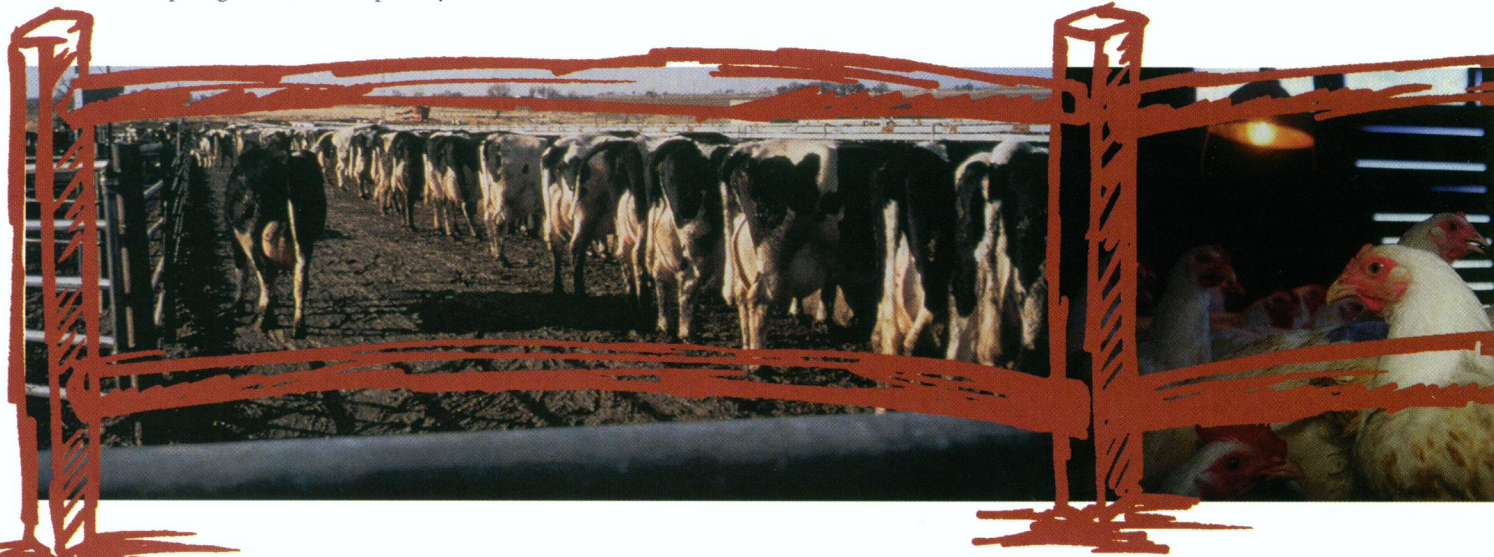
also produce their share of waste. The United States's 46.5 million milk and beef cows produce 500 million tons of waste per year, and the 7.5 billion chickens and turkeys produce 300 million tons of waste per year. These figures are conservative: altogether, livestock produce a staggering billion tons of waste annually, according to a paper by B.L. Harris, an extension specialist at the Crop and Soil Science Department at Texas A&M University, and his colleagues in the proceedings of the 1994 Great Plains Animal Waste Conference on Confined Animal Production and Water Quality.

Managing that much waste would not be easy under the best of circumstances. But the problem is exacerbated by the fact that there is little demand for the waste. Before the advent of chemical fertilizers, farmers typically raised both livestock and crops and used the animal waste as fertilizer. Today most farmers specialize in either crops or livestock, which means that the waste would have to be hauled to the crop farms. And using chemical fertilizers is cheaper.

Another reason that livestock waste is difficult to deal with is that enormous

amounts are produced in relatively small areas. Most livestock operations pack huge numbers of animals into confinement buildings or feedlots, a practice that makes sense economically because in general the more animals raised in one place, the cheaper the cost per animal. In North Carolina, for instance, 10,000-head hog operations are not uncommon. (Hog confinement operations usually allot an average of about eight square feet per animal.) Beef cattle feedlots can hold up to 50,000–100,000 head in Texas, the state that produces the most feedlot cattle. And operations that produce broiler chickens raise as many as 400,000 at a time in Arkansas, the top broiler-producing state.

To make matters worse, livestock operations are often clustered near processing plants because the closer the livestock operations are to a plant, the cheaper the costs of transporting the animals there. Most of North Carolina's 7.6 million hogs are raised near a Smithfield Foods-owned hog-processing plant in the eastern part of the state. About 80% of the hogs are raised on only 10% of the state's 7,000 operations.





## Lagoon Spills

The North Carolina hog industry has tripled in size since 1990, making it the fastest-growing as well as the largest in the country. This growth has come at a cost, however. Most waste from hogs and cows raised in confinement is collected in lagoons, which are large, shallow pits dug into the ground. The waste solids sink to the bottom of the lagoon and are broken down by anaerobic bacteria over a period of months. In theory, operators keep the lagoons from overflowing by spraying the liquid that rises to the surface on nearby fields.

In practice, however, these lagoons do not necessarily contain the waste. The most dramatic evidence for this came on June 21 of this year, when North Carolina suffered the largest agricultural waste spill in its history: a 7.5-acre, 12-foot-deep lagoon leaked 25 million gallons of hog waste into the headwaters of the New River near Richlands. The waste from the 10,000-head operation, owned by Oceanview Farms, contaminated the water for several miles downstream, increasing the levels of nitrogen, phosphorus, and other nutrients. When nutrient levels dramatically increase in rivers and other bodies of water, algae grow furiously, consuming most of the dissolved oxygen and asphyxiating the other aquatic organisms living there. An estimated 5,000 fish died as a result of the Oceanview Farms spill. Nine subsequent waste lagoon spills—six in North Carolina and three in Iowa—showed that this was not an isolated occurrence.

Waste from livestock operations is particularly copious and nutrient-rich because animals raised in confinement are fed plentiful amounts of high-quality food. "We want animals as fat as we can get them; we want cows to give as much milk as possible. If you put a lot in the front, you get a

lot out the back," says David Holsinger, state non-point source coordinator at the North Carolina Division of Environmental Management (DEM).

Downstream of the spill, the New River also had high fecal coliform bacteria counts. Fecal pathogens that can be transmitted from livestock to people include enteric bacteria such as *Salmonella* and *Shigella* and protozoa such as *Cryptosporidium* and *Giardia*. People could potentially be exposed to these pathogens by fishing or swimming in contaminated waters or by eating shellfish, which are filter-feeders and can concentrate pathogens.

Livestock waste has been implicated in outbreaks of human disease, notably the spring 1993 cryptosporidium infection that afflicted 4,000 people in Milwaukee through the public water supply. But the link is difficult to trace conclusively. "The human health effects [of livestock waste] are unknown," says James Oliver of the biology department at the University of North Carolina at Charlotte. "There are lots of enteric pathogens in fecal coliform [bacteria], and you would expect there to be an increased health risk, but there are no studies showing that. The spill in the New River provides an interesting opportunity to study any health effects," he says, adding that he and his colleagues are planning such a study.

When investigating the Oceanview Farms hog waste spill into the New River, North Carolina DEM officials found that the lagoon had not been operated properly. An irrigation pipe had been bored through the lagoon's earthen wall, which weakened it. The truck-sized hole through which the waste spilled was near the pipe. In addi-



**Susan Schiffman**—The amount of anger people have over odor pollution is tremendous.

tion, the lagoon had been overfilled: the wastewater nearly reached the top of the lagoon rather than stopping 20 inches short of the top as stipulated in the operator's waste management plan. Moreover, the operator had failed to clear enough acreage for spraying the wastewater from the lagoon: only 44 of the 102 acres stipulated in the waste management plan had been cleared. Ironically, this was the first lagoon to receive a permit under stricter state

standards for animal waste adopted in 1993. The DEM fined Oceanview Farms \$110,000, but the company will appeal, said Bill Johnson, vice president of Coastal Ag-Development, Inc., the registered agent for the company, in a 23 August 1995 article by the Associated Press. "We have submitted a formal written report [to the state] that outlines how we complied with the waste management plan for Oceanview Farms," he said.

In response to the series of livestock waste spills, North Carolina Governor James Hunt ordered the DEM to investigate the lagoons on the state's largest hog operations. The investigators found 109 operations that were discharging hog waste directly into streams and rivers, 124 lagoons that were so full that they were likely to overflow or burst, and 526 that were nearing that critical point of fullness. Although record June rains were cited as a reason for the lagoon problems, lagoons are supposed to be able to handle heavy rainfall, says DEM spokesman Don Reuter.

The waste spills in North Carolina are a warning to all livestock-producing states. "Problems become public here first primarily because the animal confinement industry has taken off due to the laxity of







Reagan M. Waskom

**Paying for spraying.** Overspraying fields with liquid animal waste can lead to excessive odor and to runoff in nearby streams.

the political climate [in North Carolina], but the problems are basically the same nationwide,” says the DEM’s Holsinger.

### Chronic Seepage and Runoff

Although spills focus attention on the hazards of livestock waste, the greatest threats are chronic seepage from lagoons and runoff from the fields where the lagoon liquids are sprayed, according to Kenneth Pollig, an environmental engineer in the groundwater section of the North Carolina DEM. Some waste lagoons are lined with compacted clay or plastic, but most are not. “The main route of contamination is through the soil. Waste migrates into nearby streams and aquifers,” says Pollig. Livestock waste contamination can increase the level of nitrates in groundwater, which can cause methemoglobinemia or “blue baby syndrome.” In this rare but potentially fatal disease, intestinal bacteria metabolize the nitrates to nitrites, which oxidize the iron in hemoglobin, rendering it incapable of binding oxygen. Babies less than six months old are particularly susceptible to this syndrome, in part because their digestive tracts are less acidic than those of adults, which favors the growth of the nitrate-converting bacteria.

Groundwater contamination is of particular concern in the coastal plains of eastern North and South Carolina, where the water table is only 15–20 feet below the surface of the soil. “Twenty-five percent of the lagoons in the Carolinas are in the coastal plains, and the bottom of the lagoon can dip below the water table,” says Pollig, citing a 1994 doctoral thesis by Maolin Zheng of Clemson University’s

Department of Agricultural Engineering. Zheng studied 36 hog and poultry waste lagoons and found that 65% of them leaked into the groundwater. “Some hog farmer can basically dig [a waste lagoon] wherever he wants and build it however he wants,” says Pollig. “But that’s changing now.”

Groundwater contamination is also a problem in Weld County, Colorado, where 500,000 beef cattle are raised in feedlots. “The fields are loaded with manure. It’s too expensive to haul away,” says Reagan Waskom, an extension water quality specialist at Colorado State University. The towns around the feedlots have high nitrate levels in their groundwater—about 20 ppm, which is double the EPA standard, says Waskom.

Another source of water contamination is runoff from the fields where livestock waste is applied. Although some poultry waste is collected in lagoons, most poultry operators use a “dry system” that involves putting, for example, sawdust on the floor to catch the waste and then plowing the sawdust into fields. Waste from lagoons is supposed to be sprayed on fields at agronomic rates; in other words, the plants growing in the fields are supposed to be able to take up all the nutrients in the waste. But many operators spray too much liquid on too little land, says William Holman, a lobbyist for the North Carolina chapter of the Sierra Club, resulting in runoff.

### Airborne Health Effects

“Too much spray also leads to drift [through the air], which carries odor,” says Holsinger, who was on North Carolina’s

Swine Odor Task Force. While odor transmission and control are poorly understood, one thing is clear: living downwind of hog operations adversely affects people’s moods, according to a 1995 study published in the *Brain Research Bulletin* by Susan Schiffman and her colleagues in the Department of Psychiatry at the Duke University Medical Center.

The study compared the moods of 44 people living near hog operations with those of a control group (matched for age, gender, race, and years of education). The subjects rated their moods by filling out Profile of Mood States questionnaires (POMS), which reveal transient mood shifts. Subjects living near hog operations filled out POMS on days when they could smell hog odors, and the results showed that they are more tense, angry, and depressed, as well as more tired and confused than average.

“The amount of anger people have over odor pollution is tremendous. The smell gets into bedding, carpets, and drapes. People can’t sell their houses because no one wants to live near a hog farm,” says Schiffman, who was also on the state Swine Odor Task Force. “Dairies and poultry farms also smell. Farmers are following all the laws and don’t know what to do. There is no legislation for odor standards—there has not been enough research to set odor standards or to know how to intervene and fix the problem.”

Besides being affected by living near livestock operations, people may be affected by working in them. Workers in livestock confinement buildings breathe in dust from waste and feed, which may cause or exacerbate respiratory diseases such as asthma, bronchitis, and even chronic obstructive pulmonary disease. However, there is only anecdotal evidence that breathing in livestock waste dust causes chronic pulmonary disease, says John Pickrell of the environmental toxicology department at Kansas State University in Manhattan.

Other little-understood but potentially adverse effects of airborne livestock waste include global warming and atmospheric nitrogen deposition. Waste lagoons may contribute to global warming because they produce the greenhouse gases carbon dioxide and methane. Lagoons may also contribute to atmospheric nitrogen deposition because they produce ammonia, which evaporates both directly from the lagoons and from the wastewater sprayed on fields. “When you drive by a lagoon you can smell the ammonia,” says James Pinckney, visiting assistant research professor at the Institute of Marine Sciences (IMS) of the



University of North Carolina at Chapel Hill. Atmospheric nitrogen rains down into streams, rivers, lakes, and coastal waters. The increased nitrogen then contributes to the algae blooms that deprive fish and other aquatic organisms of oxygen.

Although there is no direct evidence that livestock waste lagoons are contributing to acid rain, they are likely to be a major source, says Pinckney, who works with IMS researcher Hans Paerl. Their studies have shown that the average amount of ammonia in eastern North Carolina's rainfall increased by about 25% from 1990 to 1995, which coincides with the increase in hog farming. Paerl plans to determine how much of this ammonia comes from waste lagoons by measuring the compound's nitrogen isotope ratio, which is characteristic of the source.

### Waste Regulation

The EPA requires no-discharge systems for confined livestock operations and considers waste lagoons to be non-discharging. The basic requirement is that lagoons must be able to accommodate all runoff except in the event of rainfall greater than a 24-hour, 25-year storm—that is, the amount of rain that falls in 24 hours during the biggest storm in a 25-year period.

Seepage from lagoons and spray and runoff from waste-treated fields are, like other non-point sources of pollution, poorly regulated. "Non-point pollution is a kind of big, amorphous beast that no one can really characterize," says Holsinger. While the EPA estimates that livestock production contributes between one-third and one-half of the non-point surface water pollution in the United States, this estimate is controversial.

The EPA has the authority to regulate livestock waste under the Clean Water Act, but instead largely leaves this to the individual states. But state standards are not all that strict. Texas has approached the task of controlling water contamination by livestock waste "more seriously than most states," wrote John Sweeten, associate department head and extension

program leader for agricultural engineering at Texas A&M University, in the proceedings of the 1994 Great Plains Animal Waste Conference on Confined Animal Production and Water Quality. But even so, he says, only 50–70% of dairy farms are in compliance with no-discharge requirements in Erath County, Texas, where about 70,000 dairy cows are kept within a 50-mile radius.

North Carolina may represent the other end of the regulatory spectrum. "North Carolina standards and enforcement are weak. There was virtually no enforcement until this summer. It was complaint-driven," says the Sierra Club's Holman. When corporate hog farming began booming in North Carolina, "we predicted how bad the odor would be and that the lagoons would leak, but no one in the government would listen to us. And now it's happening," says Don Webb, a former hog farmer who is now the president of the Alliance for a Responsible Swine Industry. "The govern-

ment turned its back on us for rich, powerful people," Webb says. Schiffman of the Duke University Medical Center concurs, saying, "State regulators looked the other direction."

North Carolina regulators are paying more attention to livestock waste now. Under bills enacted this summer, livestock operators must be trained to apply waste on land and must pass a certification test, and the state must inspect all new waste lagoons. In addition, new hog operations must be located at least 1,500 feet from houses and 2,500 feet from schools, hospitals, and churches. These distances, according to Holsinger, were the suggested standards of the National Pork Producer's Association.

### Solutions to Management Problems

Despite the new regulations in North Carolina, Holsinger and others think that the regulations do not go far enough. Commenting on the new location requirements

for hog operations, Holsinger says, "Fifteen hundred feet is about a quarter of a mile, which is nothing compared to a six-acre lagoon." Furthermore, operators of old lagoons do not have to comply with most of these new regulations. Holsinger calls for inspecting and, if necessary, retrofitting older waste lagoons with liners. The North Carolina DEM is now studying leakage in unlined lagoons. Holsinger and others also call for keeping lagoons away from surface waters. "Some old lagoons are right next to streams. It would be best if they were relocated," says Roger Thorpe, water quality supervisor at the North Carolina Department of Environmental Health and Natural Resources.

Some North Carolina legislators also want tougher regulations. State representative Howard Hunter wants counties and towns to be able to pass zoning laws to keep hog operators from building on unsuitable sites. "Rural areas are exempt from zoning," says Holsinger. "A little agricultural community can't do anything about a mega-hog farm moving in and bringing with it odor and groundwater problems." U.S. Congressman Charlie Rose wants the EPA to regulate livestock waste more stringently. But that would



**Sniffing out answers.** John Sweeten (left) and a technician use scentometers to test odor strength at a cattle operation.

Texas Agricultural Extension Service



merely provide the state officials with an excuse to avoid dealing with livestock waste because they would be able to blame the EPA for any problems, countered the *Fayetteville Observer-Times* in a 30 August 1995 editorial.

Others call for tightening existing state regulations, which are not necessarily consistent with each other. "There's no coordination of regulatory agencies," says Deanne Morse, livestock waste management specialist at the University of California, Davis, citing California regulations that are designed to control mosquitoes but that have unforeseen adverse effects on lagoon integrity. Operators are told to lower lagoon levels to kill the floating weeds where mosquitoes like to lay their eggs, but when the water level in a clay-lined lagoon goes up and down, the cycle of wetness and dryness makes the lagoon more likely to crack, she says.

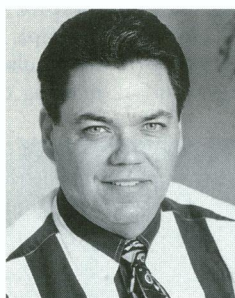
Besides disagreeing about the level and extent of regulatory reform, people disagree about the level of technology that is necessary to treat livestock waste safely. Some say that when used properly, cur-



Reagan M. Wastom

**Blue lagoon?** Catastrophe can result when waste lagoons are allowed to overflow or when leaks occur due to improper lining.

rent waste treatment methods are adequate. "There are data on both sides of the fence, but my personal experience is that it's a question of [the operator's] management," says Morse. "[Waste lagoons] are not an exciting place to go. It's the last thing [operators] want to do, but it's an effort they need to make."



NCPA

**Walter Cherry**—We need to find a balance between producing livestock and protecting the environment.

Others say that livestock operators need to adopt new waste treatment technologies. The Sierra Club's Holman would like livestock operations to use more advanced treatments such as those used for

human waste but, he says, the animal industry says they are too expensive. Walter Cherry, president of the North Carolina Pork Producers Association, agrees that livestock operators need to protect water supplies and control odor but emphasizes that "we need systems that adequately address all factors and are still economically feasible. We need to find a balance between producing livestock and protecting the environment." The North Carolina Pork Producers Association is funding a study by the Duke University Medical Center's Schiffman to identify the odor-

causing compounds and determine ways of managing lagoons to decrease the odor.

While there is no consensus on how to deal with livestock waste, almost everyone agrees that there is a need to educate livestock operators better and fund more research to determine the best ways to manage livestock waste. As devastating as the hog lagoon spills last summer were, they may ultimately benefit the health of the environment and public health by forcing people on all sides of the issue to face the considerable problems that livestock waste can cause.

**Robin Meadows**

### **Course on Experimental and Clinical Neurotoxicology at Department of Nutrition Sciences University of Oporto, Portugal**

**May 27–31, 1996  
Under the auspices of  
University of Oporto, IPCS, WHO, EC.**

This course will cover the whole field of neurotoxicology and include classifications of neurotoxic substances, mechanisms and pathophysiology of neurotoxicity, clinical and functional diagnosis of neurotoxic diseases (including toxicological, electrophysiological and neurobehavioral tests), and epidemiology of neurotoxic diseases.

**Faculty:** H.H. Schaumburg, MD  
Albert Einstein College of Medicine  
New York, USA

P.S. Spencer, PhD  
Center for Research on Occupational  
and Environmental Toxicology  
Portland, OR, USA

M. Lotti, MD  
Institute of Occupational Medicine,  
University of Padua, Italy

#### **Registration and further information:**

Dr. Ana Paula Augusto, Curso Ciencias da Nutricao, University of Oporto,  
4200 Porto, Portugal, FAX: 351-2-5504143